BEFORE THE OKLAHOMA WATER RESOURCES BOARD

In re:	
SEQUOYAH FUELS CORPORATION	Application No. WD-75-074 I.D. No. 68000010

Report on

TOXICOLOGICAL EVALUATION OF SEQUOYAH FERTILIZER PROGRAM

by

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TABLE OF CONTENTS

	Page Number
Introduction	1
Qualifications	1
Overview of the Fertilizer Program	3
Toxicological Evaluation	7
Epidemiological Data	11
Conclusions	12

Appendicies

Appendix A	Resume, Ronald L. Coleman, Ph.D.
Appendix B	An Assessment of Potential Environmental and Adverse Health Impacts Resulting from Operations of the Sequoyah Fuels Facility, Gore, Oklahoma. Oklahoma State Department of Health, November, 1985.

INTRODUCTION

The Sequoyah Fuels Corporation (SFC), as part of its uranium operations in Gore, Oklahoma, produces a fertilizer that is identified by the OWRB as "treated raffinate." This fertilizer is essentially a dilute solution of ammonium nitrate. Sequoyah applies the solution to soil in a managed forage crop production and ranch operation. The current draft OWRB permit would regulate this land application of "treated raffinate" as a waste-disposal operation and would require an extensive monitoring program.

This report is prepared with full recognition of the need to protect the environment. In the opinion of the author, however, the proposed OWRB regulation is overly stringent. The regulation of the fertilizer solution as a waste is neither warranted nor desirable. The terms of the draft permit would establish extraordinarily extensive sampling requirements, but result in essentially no improvement in environmental protection.

I. QUALIFICATIONS

This report is prepared by Ronald L. Coleman. I am an environmental toxicologist, and am a Professor and Chair of the Department of Environmental

Health, College of Public Health, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma.[1/] My academic education includes a B.S. in Chemistry from Abilene Christian University and a Ph.D. in Biochemistry from the University of Oklahoma. In some 24 years as an O.U. faculty member, my responsibilities have included research and teaching at the graduate level in the area of assessing the impacts of pollution on the environment, with special focus on the toxicology of heavy metals.

I have served as a consultant on numerous occasions, including projects involving the land application of municipal-wastewater treatment-plant sludge. I have worked with approximately 15 to 20 Oklahoma cities and towns, and have directed programs requiring an estimated 1,000 analyses of sludges and soils across Oklahoma. As a result, I have developed an extensive knowledge of successful environmental protection practices in the State.

I recently was requested by Sequoyah Fuels Corporation to review and evaluate Sequoyah's usage of the ammonium nitrate fertilizer (including data extending from 1973 to the present) and the proposed OWRB permit.

[1/] My resume is attached as Appendix A.

II. OVERVIEW OF THE FERTILIZER PROGRAM

A. Environmental Protection

Pollution is defined as the presence of an undesirable material in the environment such that an adverse effect results. Often pollution involves a material located at the wrong place, at the wrong time, and/or at the wrong concentration. Pollution does not occur if a desirable material is present in the correct environment in appropriate concentration at the right time. Thus, often pollution can be avoided — in fact, a societal benefit can result — by altering the "when, where and how much" of a material. Indeed, perhaps the most societally desirable environmental protection strategy is to encourage industry to take materials that might otherwise be wastes and to turn them into valuable products that do not threaten the environment. These principles are well illustrated by SFC's handling of the raffinate produced in its uranium-processing operations.

The conversion of yellowcake to uranium hexafluoride results in the production of a byproduct stream known as "raffinate." Prior to 1973 this material was handled as a waste. As it happens, however, the material is rich in nitric acid and, thus, Sequoyah investigated whether the raffinate might be used to produce a fertilizer. Sequoyah now processes the raffinate to convert the nitric acid into ammonium nitrate, which is the common chemical form for nitrogen fertilizers,

and to purify the solution to remove harmful constituents. In short, Sequoyah found a way to convert a waste into a desirable agronomic nutrient. At every stage of SFC's exploration of the production and use of the fertilizer, the NRC exercised control and oversight to assure that no inadvertent harmful effects to the environment or the public could result.

The NRC approach to regulation of the fertilizer program appears to have focused on encouraging the beneficial use of the byproduct. The OWRB staff approach, by contrast, is to regulate the fertilizer as a waste. But to treat this material as a waste does not fulfill the intentions of pollution control, which should facilitate resource reclamation and resource conservation.

The simple fact is that the ammonium nitrate solution is a fertilizer. Analyses demonstrate that it is carefully applied on a sound agronomic basis and that it poses less threat to the environment and public health than other commercial fertilizer materials.

In Table I, I have compared sewage sludge and the ammonium nitrate fertilizer on the basis of various toxicological criteria. Sludge from municipal sewage-treatment plants is also high in nitrogen and the author has extensive experience in the land application of this material. The table enables one to evaluate whether any constituent occurs in sufficient concentration to merit concern because of a potential to cause an undesirable effect.

TABLE 1

	CONSTITUENT	SLUDGE	AMMONIUM NITRATE SOLUTION
1.	Pathogens	Potentially present, variable	Not present
2.	Persistent Organics (e.g. PCB)	Present, concentration variable	Not present
3.	Pesticides & Herbicides	Can be present, wide variation in concentration.	Not present
4.	Heavy metals	Present, variation in concentrations, possible to cause undesirable effects,	Present, narrow range of variance, concentration inadequate to cause undesirable effects.

As may be seen, a dramatic difference exists between sewage sludge and the ammonium nitrate solution. Because sewage sludge is considered to be low risk for environmental pollution and because the ammonium nitrate's potential risk is much lower than sewage sludge,[2/] the solution should not be regulated if it is added to land within limits established based on sound agronomic principles, — that is, if it is used as a nitrogen fertilizer.

[2/] The only group of constituents with potential environmental significance common to both the solution and sludge are the metals. The lack of environmental toxicity from the metals in the ammonium nitrate solution is discussed in Part III.

B. Data

SFC has conducted exhaustive sample collection and analyses. These include soil analyses before and after application of the ammonium nitrate solution, analyses of the solution, analyses of crops, examination of a test group of animals that consumed the forage, and the sampling of runoff and ground water. It is obvious that an extensive, indeed exhaustive, data base exists. Suffice to say, the sweep of analyses is more extensive than that undertaken with any land application program (such as the use of sewage sludges) of which I am aware. And all this data demonstrates the program is completely safe.

The OWRB Permit Rationale (page 20) asserts that the current monitoring program is not as extensive as needed and that it should be expanded to cover a larger area. It suggests that after SFC establishes a historical data base, the program could be adjusted up or down as necessary to protect the waters of the state. Because I have seldom seen a data base that is as comprehensive as that assembled over the years by Sequoyah Fuels Corporation, these statements are simply incredible to me. It is my opinion that expansion of the testing program is not indicated.

SFC's development of the fertilizer program has employed a "test plot" approach to asssess environmental impact. This is based upon a careful

identification of all soil types and the conduct of an extensive set of analyses on test plots representing each type. Due to the size and replication of the test plots, sample validity can be demonstrated. This approach — the use of "test plots" representing all soil types — yields results that are as meaningful as the comprehensive testing urged by the OWRB staff. Indeed, the "test plot" approach allows exhaustive analyses to be conducted at reasonable total cost.

III. TOXICOLOGICAL EVALUATION

The author has extensive experience in evaluating heavy metal and chemical toxicity.[3/] I have examined the solution and found no constituent that warrants regulatory concern.

A. Nitrogen

The primary component of the solution is nitrogen. Too little nitrogen will limit benefits by not supplying plant needs, levels in the correct range yield optimum crop production, while too much exerts a phytotoxic effect and may allow

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3/I have not considered the effects of radionuclides because the toxicity of such materials is outside my experience. The radionuclide content has been examined by others.

potential water pollution. Scientifically based limits are observed by Sequoyah to avoid over-application, with the limits geared to the crop actually produced. The soil is evaluated before and after crop production in order to develop knowledge as to the amount needed for proper forage production.

An examination of the historical data base reveals no reason for toxicological concern with respect to nitrogen and its metabolic species either in grain, forage, forage animals, water or adult humans. The examination indicates an extremely low risk for any environmental pollution. Indeed, a report from the Oklahoma State Department of Health concluded (p.vi), with respect to nitrogen compounds, that there were "no adverse impacts on surface water, ground water, or air as a result of the operation of this facility".4/

The current OWRB draft permit includes a limit for nitrogen of 700 lbs/per acre per year. It is not apparent why the OWRB seeks to regulate nitrogen application in view of the widespread unregulated use of similar fertilizers by

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4/This report is attached as Appendix B.

agricultural operators throughout the State. Moreover, the proposed limit is not sufficiently flexible to accommodate the growth of two crops in one year, or the need for excess nitrogen application to soils that are extremely nitrogen deficient.

B. Heavy Metals

I have examined in detail the trace amounts of heavy metals that are present in the fertilizer.[5/] For convenience of discussion, I have divided these into 2 groups: 1) those substances which may be essential to life for plants and/or animals at low concentrations and 2) those substances for which there are few if any beneficial effects.[6/]

5/Table 2 sets forth a comparison of the metal constituents of the fertilizer with sewage sludge on a nitrogen-equivalent basis. Sewage sludge is regulated primarily because of the concentrations of lead and cadmium. The concentrations of these elements in the fertilizer are about a factor of 70 less than those in sludge on a nitrogen-equivalent basis.

6/With respect to this latter group, it must be stressed that presence does not necessarily equate to a toxic response. Plants, animals, and humans, can tolerate or detoxify small amounts of these materials: "no effect" levels exist.

1.) Essential Nutrients (B, Ca, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Se, V and Zn). Certain metals are essential to plants and/or animals and man at optimum concentrations. In some cases, the SFC soils are too low in one or more of these substances and must be supplemented. Even after SFC fertilizer treatment, soil levels for most of these materials are less than optimal for plant growth and reproduction. Therefore, proper agronomic management requires additional amounts of these elements be added to the soil. This group includes B, Co, Cu, Fe, Mn, and Ni. The levels of Ca and Mg are supplemented by SFC, by application of soil amendments (Ag-Lime, K_2O, K-Mag, and P_2O_5), to bring the soils to optimal concentrations for plant growth and reproduction. The remainder of the substances are present after application of the SFC fertilizer in insufficient concentrations to be of either a deficiency or surplus concern.7/

2.) Inessential Metals (As, Ba, Cd, Hg, Pb). None of the inessential metals are found in concentrations in SFC's ammonium nitrate fertilizer as to ever present a concern. Obviously, none have accumulated in the soil.

7/At one point, molybdenum concentrations in forage did approach undesirable levels. The addition of sulfate has reduced the plant levels to normal values.

The fertilizer falls into an extremely low category of toxicological risk. Historical data (8 to 10 years) on soils (before and after SFC fertilizer application), forage, cattle, surface water and ground water demonstrate no adverse effects from the program. I conclude that the provisions in the OWRB draft permit to regulate the fertilizer are unwarranted.

IV. EPIDEMIOLOGICAL DATA

Although the evaluation of the fertilizer program would suggest a negligible likelihood of adverse impacts on humans, I have also examined the human data. The only available epidemiological study of which I am aware was conducted by the Oklahoma State Department of Health. This study is attached as Appendix B.

The OSDH study conducted statistical analyses to determine whether Sequoyah County and counties contiguous to Sequoyah County (Adair, Cherokee, Haskell, LeFlore, and Muskogee Counties) showed any indication of a significant increase or abnormal incidence of cancer-related deaths. The study found (p.44) that there was "a statistically significant decrease in total cancer deaths in Adair County and that there was no statistically significant difference in cancer-related deaths in the other counties studied."

The OSDH recognized the study had some limitations and recommended a follow-up study to address some or all of these limitations. The OSDH is currently conducting this follow-up study and it is my understanding that the preliminary data are consistent with the major finding in the first study — no significant increases in cancer-related deaths in Sequoyah County or in the adjacent counties.

CONCLUSIONS

On the basis of my analyses, I reach the following conclusions:

1. The ammonium nitrate solution should be treated as a fertilizer, not as a waste. It should not be regulated by the OWRB if other fertilizers are unregulated.

2. Extensive historical data exist. These data justify elimination, or at the least, substantial reduction of the draft permit's requirements.

3. The "test-plot" sampling is a valid scientific approach. Comprehensive sampling is not justified.

4. Toxicological considerations suggest little cause for concern with the fertilizer. The simple presence of an element does not constitute an adequate rationale for a sampling program unless there is a reason to anticipate pollution.

5. The requirements in the draft OWRB document are so excessive as to be punitive. The historical data demonstrate that the fertilizer program does not threaten the environment.

TABLE 2

COMPARISON OF SEWAGE SLUDGE AND SFC FERTILIZER*

	SEWAGE SLUDGE lbs./acre	SFC FERTILIZER lbs./acre
Nitrogen	600.	600.
Arsenic	0.00024	0.031
Boron	0.053	0.037
Barium	0.72	0.0035
Cadmium	0.12	0.0018
Cobalt	———	0.0098
Chronium	1.20	0.0019
Copper	4.8	0.12
Iron	24.	0.005
Mercury	0.00024	0.00007
Manganese	3.6	0.21
Molybdenum	———	0.24
Nickel	0.6	0.23
Lead	0.72	0.008
Selenium	0.006	0.006
Vanadium	———	0.005
Zinc	7.2	0.04

*Pounds per acre of elements which would be added to the soil if each is applied at the same nitrogen rate of 600 lbs. N per acre.